CLAIMS

We claim:

1.   1.   A computer data signal embodied in an electromagnetic waveform for producing
2   a computer readable definition of a photolithographic mask that define a target pattern in a layer
3   to be formed using the photolithographic mask, the computer data signal comprising:
4   a source code segment for identifying a plurality of features in the target pattern to be
5   defined using phase shifting, each of the plurality of features comprised of a plurality of edges;
6   a source code segment for placing a plurality of shifter shapes in the computer readable
7   definition of the photolithographic mask, the plurality of shifter shapes placed proximate to
8   edges of the plurality of features, wherein the plurality of features includes a first feature having
9   a first edge and a second edge, the first edge adjoining the second edge, and wherein the plurality
10   of shifter shapes includes a first shifter shape placed on the first edge and a second shifter shape
11   placed on the second edge, the first shifter shape and the second shifter shape separated by a
12   minimum distance;
13   a source code segment for assigning phase to the plurality of shifter shapes according to
14   phase dependencies and costs to create a plurality of phase shifters; and
15   a source code segment for refining the plurality of phase shifters.

1.   2.   The computer data signal of claim 1, wherein the source code segment for
2   assigning phase further comprises a source code segment for branch-and-bound phase
3   assignment.

1.   3.   The computer data signal of claim 1, wherein the source code segment for
2   assigning phase further comprises a source code segment for graph-based phase assignment.

1.   4.   The computer data signal of claim 1, further comprising a source code segment
2   for producing a computer readable definition of a second photolithographic mask, the second
3   photolithographic mask comprising a complimentary mask to be used in conjunction with the

4   photolithographic mask to define the target pattern, the second photolithographic mask defined

5   using the target pattern and the plurality of shifter shapes.

1   5.   The computer data signal of claim 4, wherein the second photolithographic

2   comprises at least one of a trim mask, a tri-tone mask, an attenuated phase shifting mask, and a

3   binary mask.

1   6.   The computer data signal of claim 1, wherein the target pattern represented as a

2   computer data signal in a first file format and wherein the computer readable definition of the

3   photolithographic mask represented as a computer data signal in a second file format.

1   7.   The computer data signal of claim 6, wherein the first file format and the second

2   file format are the same format.

1   8.   The computer data signal of claim 6, wherein the first file format comprises a

2   GDS-II stream format and the second file format comprises a mask data file in a format suitable

3   for use in mask fabrication machines.

1   9.   A photolithographic mask for defining a target pattern in a layer to be formed

2   using the photolithographic mask, the target pattern comprised of a plurality of features, the

3   photolithographic mask comprising:

4   a dark field mask having phase shifting openings, the phase shifting openings defined by

5   a process comprising

6   placing a plurality of shifter shapes proximate to edges of the plurality of features,

7   wherein the plurality of features includes a first feature having a first edge and a second edge, the

8   first edge adjoining the second edge, and wherein the plurality of shifter shapes includes a first

9   shifter shape placed on the first edge and a second shifter shape placed on the second edge, the

10   first shifter shape and the second shifter shape separated by a minimum distance;

11   assigning phase to the plurality of shifter shapes according to phase dependencies

12   and costs to create a plurality of phase shifters;

13   refining the plurality of phase shifters; and

14   producing a computer readable definition of the photolithographic mask.

1   10.   The photolithographic mask of claim 9, wherein the placing further comprises

2   placing the first shifter shape and the second shifter shape such that a cut can be admitted

3   between the first shifter shape and the second shifter shape.

1   11.   The photolithographic mask of claim 10, wherein the cut comprises an opening

2   comprised of a substantially square notch that is intersected at an offset on a forty-five degree

3   (45°) angle by a straight neck that ends in a squared off form.

1   12.   The photolithographic mask of claim 10, wherein the cut comprises a minimum

2   mask manufacturing width opening between two adjacent shifter shapes.

1   13.   The photolithographic mask of claim 9, wherein the target pattern characterized

2   by one or more of the following: at least eighty percent (80%) of the non-memory portions of the

3   layer are defined by the photolithographic mask; at least eighty percent (80%) of a part of the

4   floorplan in the layer is defined by the photolithographic mask; at least ninety percent (90%) of

5   the layer is defined by the photolithographic mask; all of the features in the critical path of the

6   layer are defined by the photolithographic mask; all features in the layer except those features

7   that are not phase shifted due to phase conflicts are defined by the photolithographic mask;

8   everything in the layer except test structures are defined by the photolithographic mask; and

9   everything in the layer except dummy structures are defined by the photolithographic mask.